Cyber Security: Critical Infrastructure Controls Assessment Framework

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Purpose

Provide an overview on assessment approach for Cyber based critical infrastructure security controls to protect against threats to the security, safety and survivability of critical infrastructure cyber assets, related services and processes.

Session Learning Objectives

- Understand what “Critical Infrastructure” and “Cyber (Physical) System” are
- Understand the challenges and issues related to the cyber security
- Understand applicable cyber security standards
- Explore the cyber security assessment approach
- Review the test techniques and tools for vulnerability assessment

INTRODUCTION

Securing Cyber Infrastructure

"The revolution in communications and information technologies have given birth to a virtual world… Cyberspace is real and so are the risks that come with it.

It's the great irony of our Information Age – the very technologies that empower us to create and build also empower those who would disrupt and destroy."

President Obama

Remarks by the President on Securing our Nation's Cyber Infrastructure

May 29, 2009

http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-Securing-Our-Nations-Cyber-Infrastructure/

What is Critical Infrastructure?

Critical Infrastructure /Assets

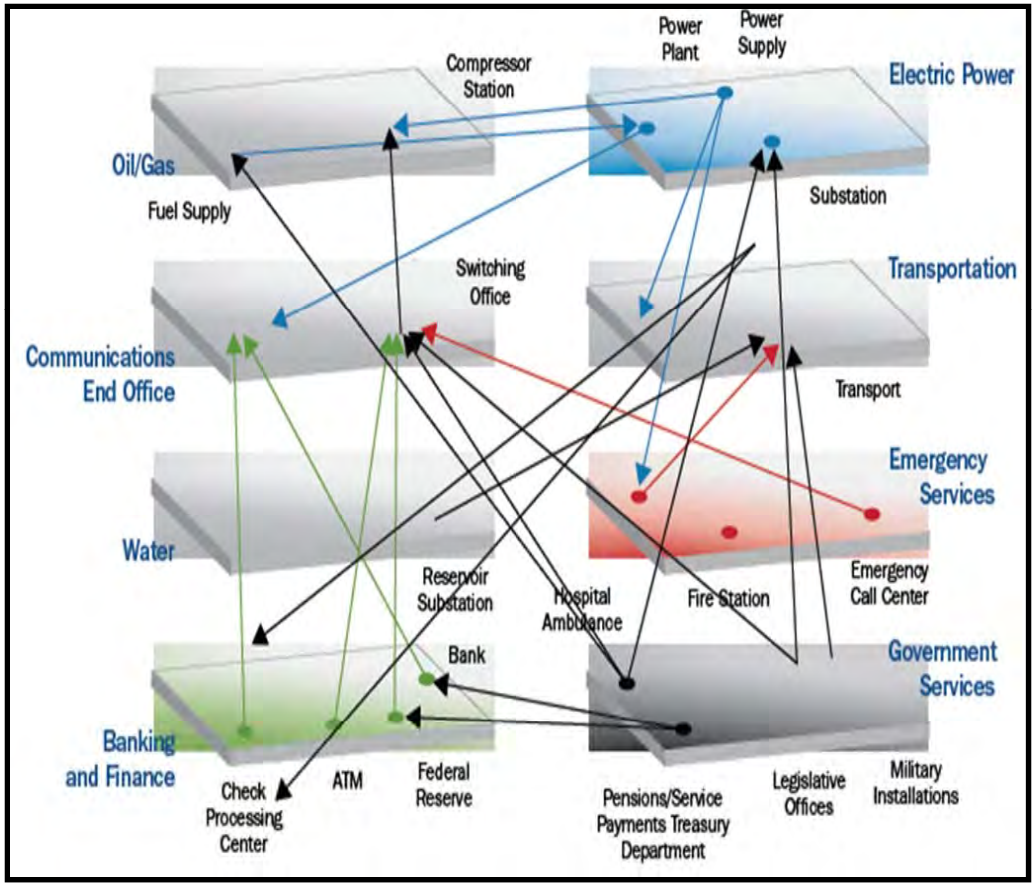
…Those facilities, systems, and equipments if destroyed, would have a debilitating impact on security, health and safety essential for functioning of a society and economy

-- USA Patriot Act (P.L. 107-56)

Critical Infrastructures are public and private institutions

Infrastructure Interdependencies

Geographical, Physical, Cyber and Logical



http://www.dhs.gov/xlibrary/assets/nipp-ssp-energy-redacted.pdf

Disruption in interdependencies can cause

- **Electricity Outage**
- **Oil & Gas Outage**
- **Water Outage**
- **Communications Outage**
- **Civil Services Interruptions**
- **Business Interruptions**
- **Emergency Services Interruptions**
- **And Many More……..**

Huge interdependencies across economy that we do not understand…….

What is Cyber?

Cyberspace

is the non-physical terrain created by computer systems. Anything related to the Internet also falls under the cyber category.

http://www.webopedia.com/TERM/C/cyber.html

Cyber System

Is composed of interconnected computers, servers, routers, switches and fiber optic cables in which online communications takes place using Internet technologies

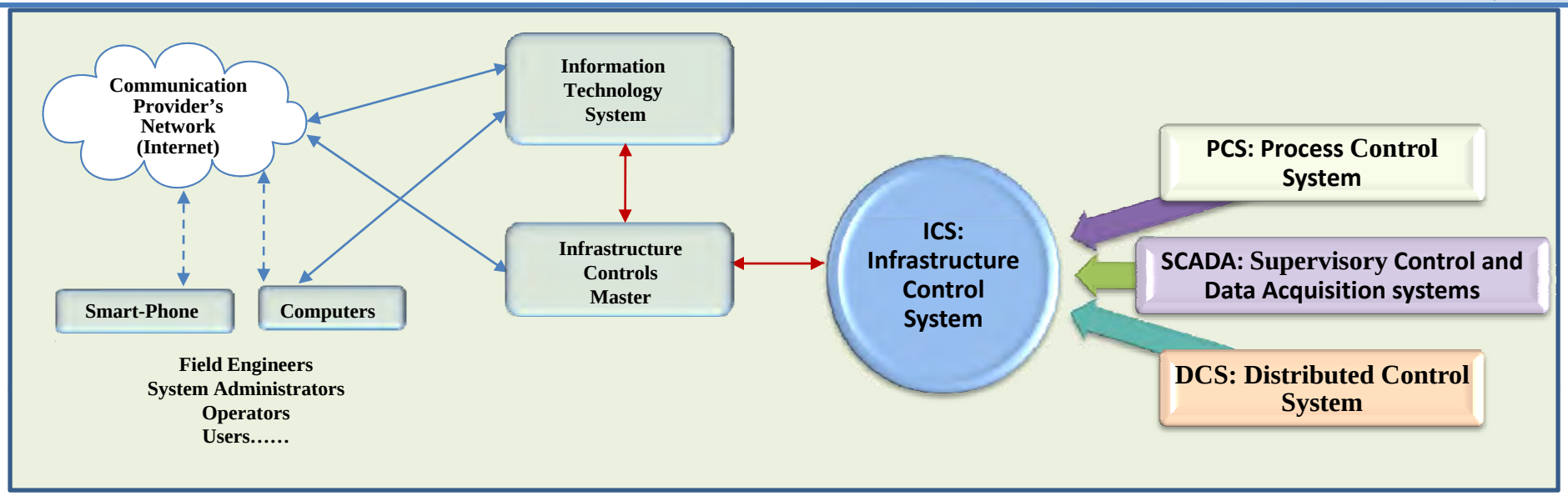
Cyber Physical System

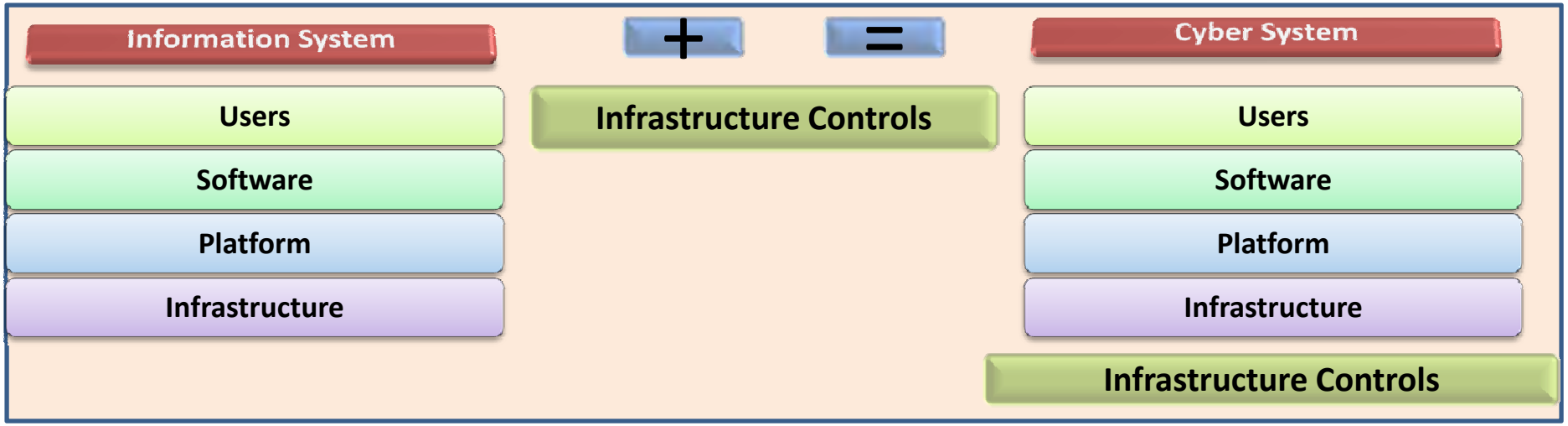
is typically designed as a network of interacting elements with physical input and output instead of as standalone devices

http://en.wikipedia.org/wiki/Cyber-physical_system

Cyber = Enabling of Internet technologies

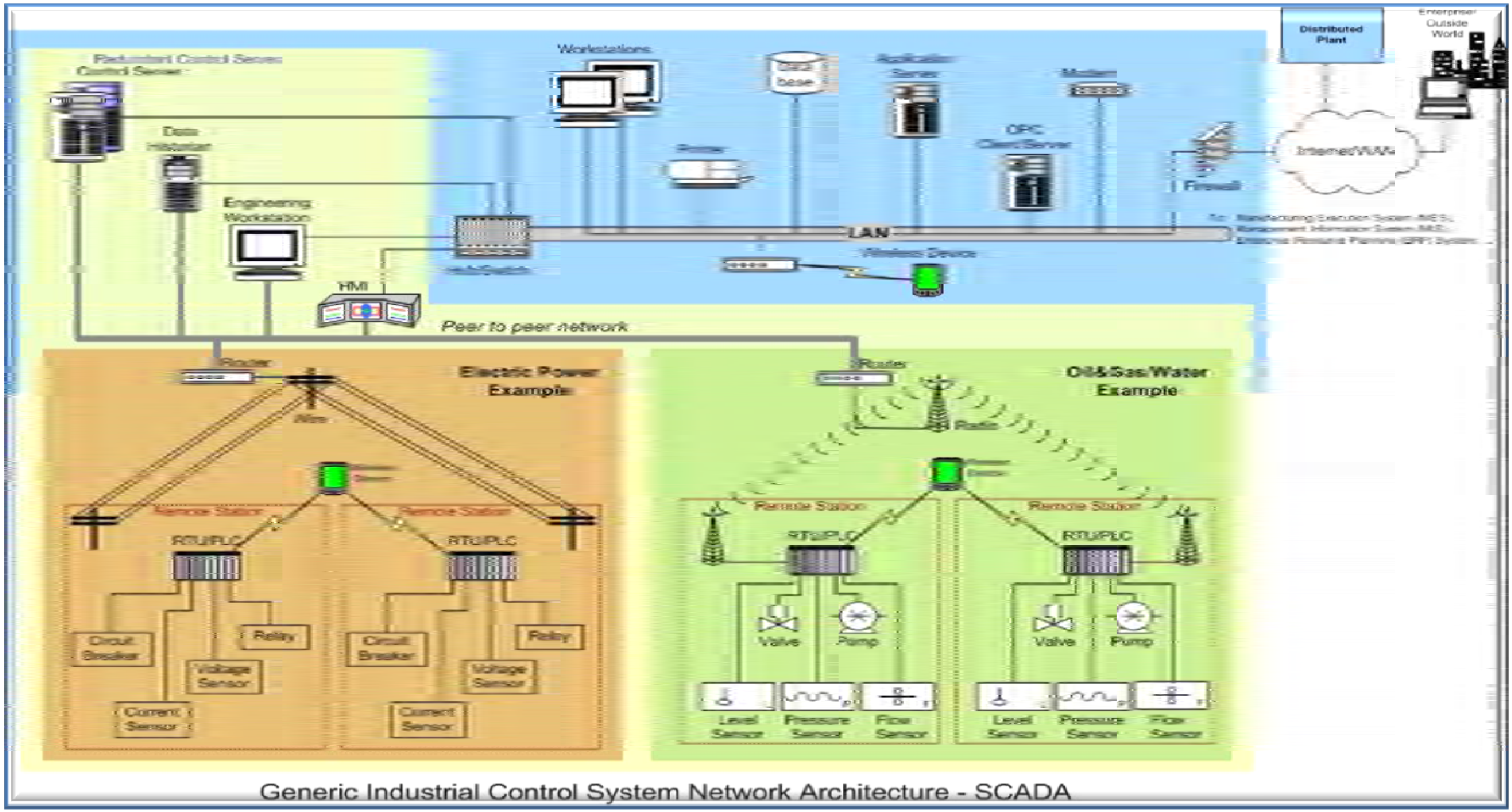
What is Cyber System?





Critical infrastructures rely upon physical and cyber-based systems for their daily operations

Cyber Physical System Example



Generic Industrial Control System Network Architecture - SCADA

http://www.isd.mel.nist.gov/documents/falco/ITSecurityProcess.pdf

Critical Infrastructure using Industrial Controls

SYNCHING-UP WITH TECHNOLOGIES: CYBER SECURITY ISSUES AND CHALLENGES

Synching-up with Technologies-1

Emerging Trends

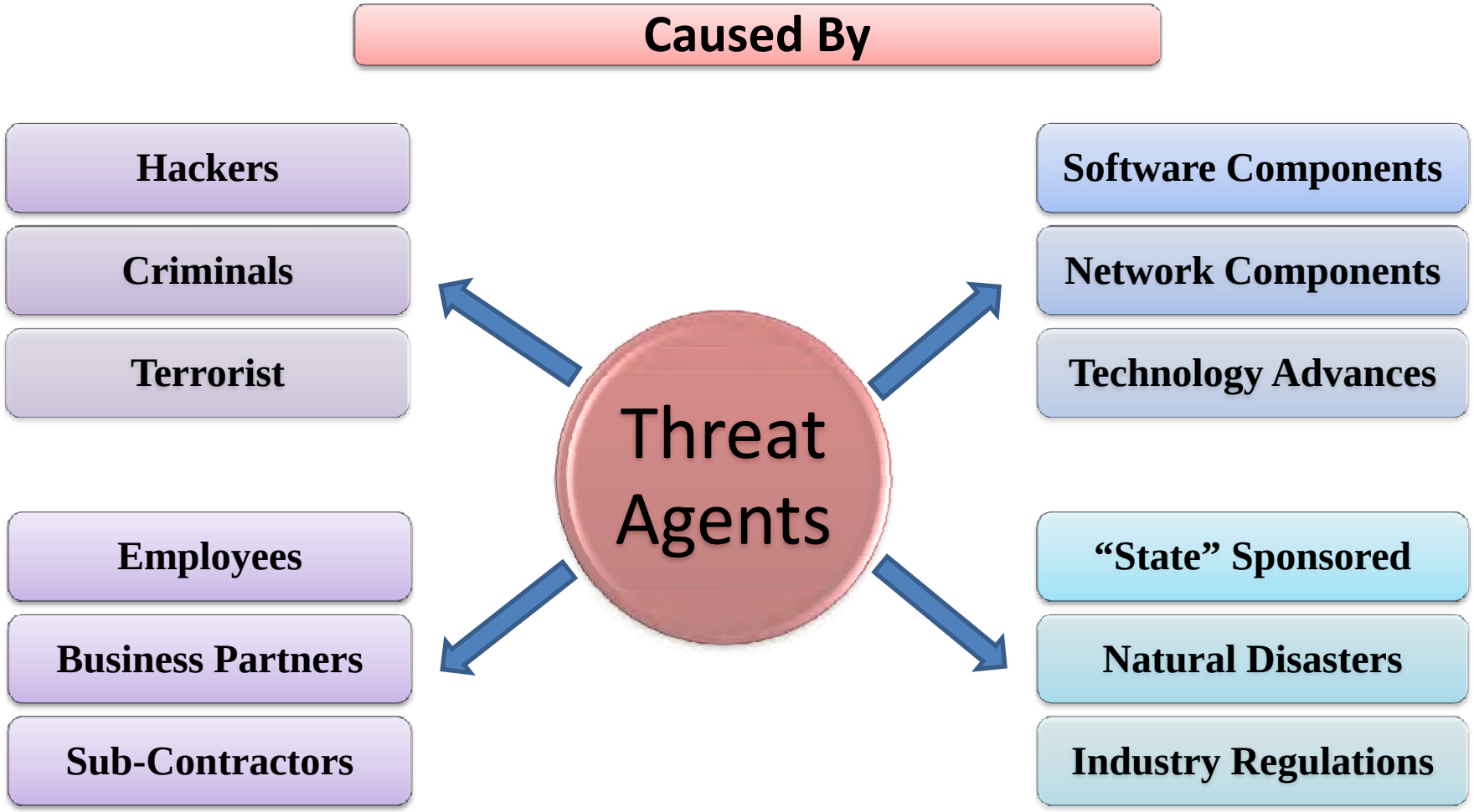
1. Transforming from paper-based to digital
2. Isolated control devices to real-time intelligent processors
3. Rapid integration of COTS and IT products and systems
4. Increasing connectivity among infrastructure control systems and information management system
5. Increasing access to infrastructure assets via Internet based technologies
6. Increasing concerns to Privacy

Emerging Threats

- Increase in malicious physical attack
- Increase in Spyware, Key loggers, Trojans
- Decrease in Time to Exploit Vulnerabilities
- Increase in well organized Cyber Crime Professionals
- Increase in use of unauthorized exploitation of standardized asset
- Increase in Network Threat Tools

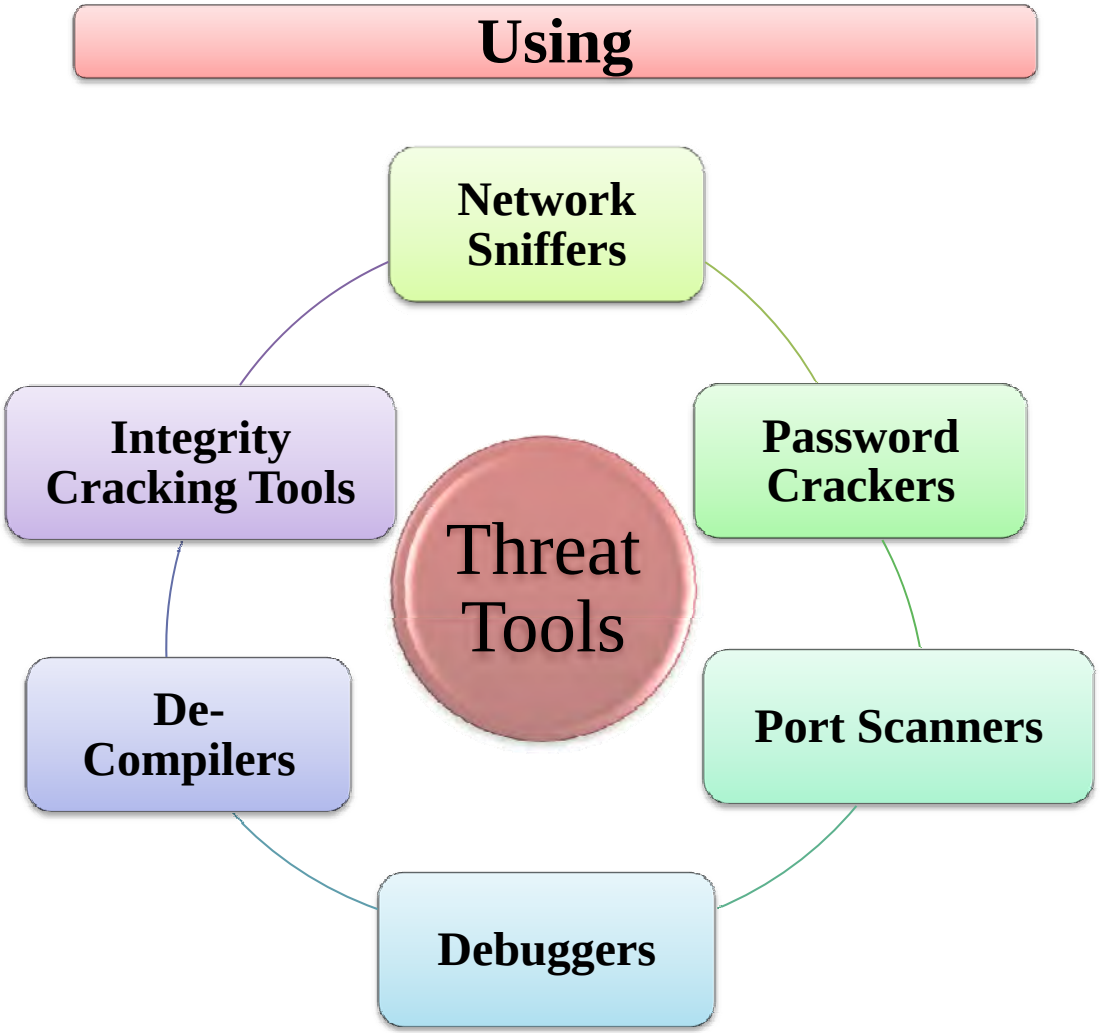
And Increasing ……..

Synching-up with Technologies-2



There are many different agents and with varying motivations in the cybersecurity domain.

Synching-up with Technologies-3



Growth of network threat tools have changed threat environment forever…..

Synching-up with Technologies-4

Causing loss of control and communications in

Transport Media	• Routers, Switches, Antenna, Towers, Conduits
Protocols	• Standard, Proprietary
Gateways	• Proxy Servers, Firewalls
Systems	• Cyber Systems, Cyber Physical Systems
Field Devices	• Sensors, Meters, IEDs, Relays, RTUs
Storage	• Database, Files

Growth of cyber technologies have changed threat environment forever…..

Synching-up with Technologies-5

Creating Impacts on

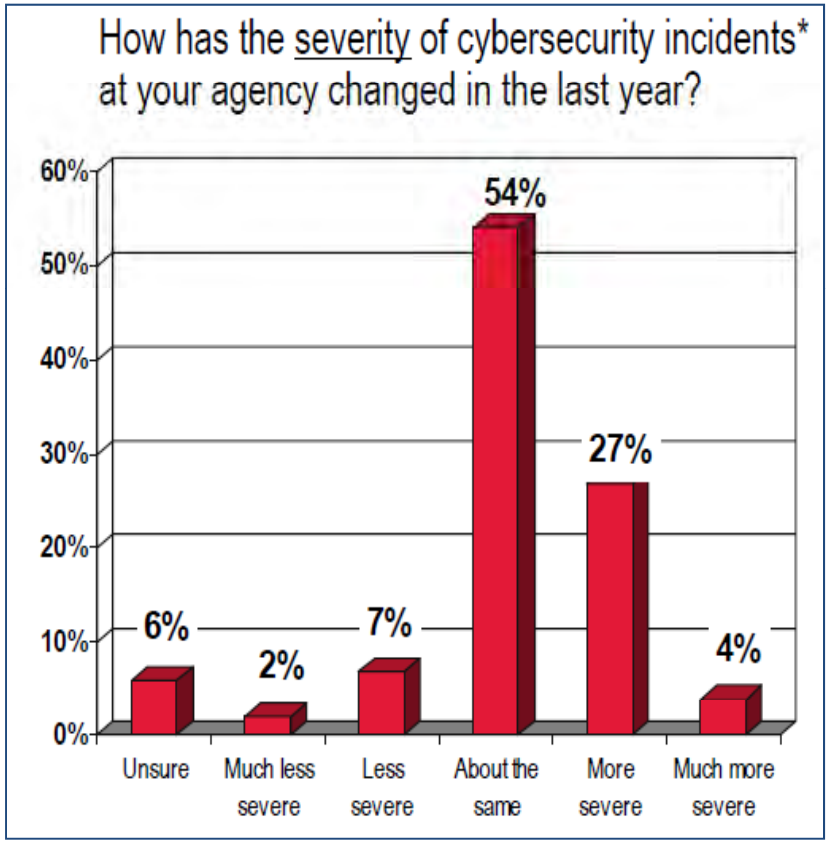
- National Security
- Public Health and Safety
- Preservation of Life
- Economic Uncertainty

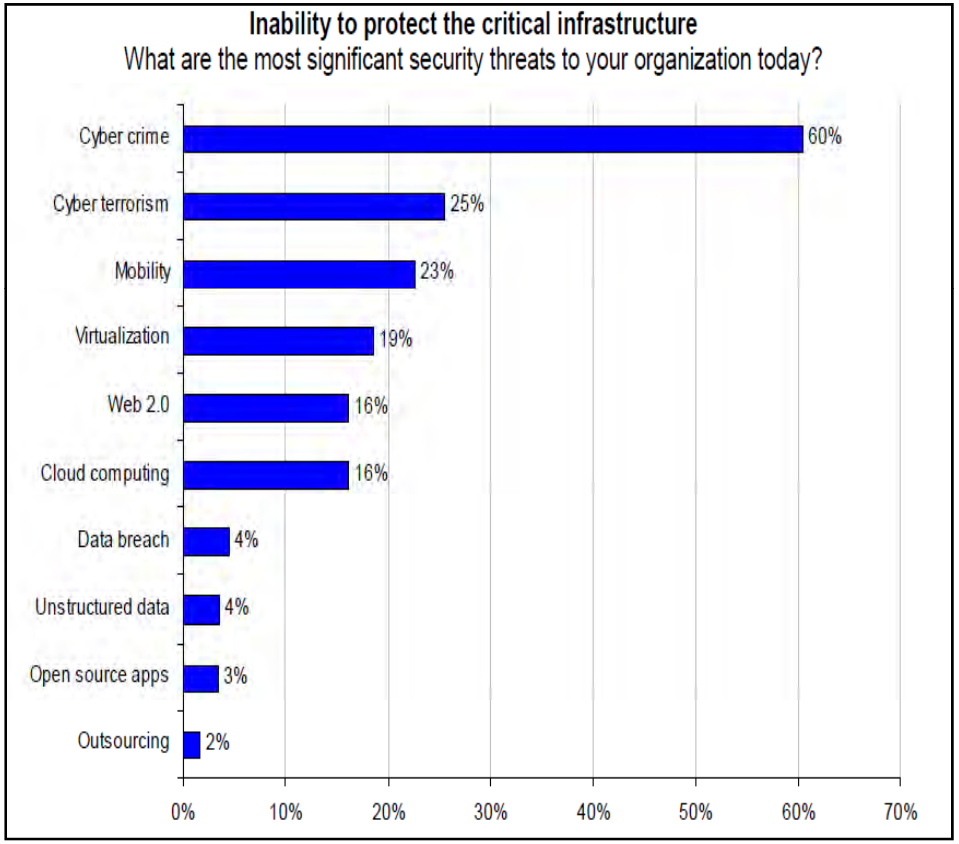
- Delays and Denial of Service
- System Destruction
- Accurate Data Management
- Customer Confidence
- Legal Liabilities

And Numerous Cascading Effect because of Domain Interdependencies

Synching-up with Technologies-6

Having Statistics





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http://www.ponemon.org/local/upload/fckjail/generalcontent/18/file/CA%20Security%20Mega%20Trends%20White%20Paper%20FINAL%202%20%282%29.pdf

Synching-up with Technology-7

Because of Gaps in Technology Assessment

- Knowledge of attack vectors used by attackers
- Security controls assessment guidelines
- Ability to identify the actual perpetrator
- Measurement guidelines for security assessment
- Skills to perform security controls assessments
- Organizational uniformity in security assessment planning

Investing in Security Assessment is NOT an Option BUT a Necessity

CYBER SECURITY REQUIREMENTS AND CONTROLS

Cyber Security Principles

Security

- Confidentiality
- Integrity
- Availability

Safety

- People
- Assets
- Nature

Survivability

- Reliable
- Responsive
- Resilient

To Support Infrastructure Protection

- National Security
- Individual Security
- Societal Stability and Security
- Economic Stability and Security
- Critical Infrastructure Security/Continuity and
- The Preservation of Natural Resources and the Environment.

To build Trust and Confidence in system environment

Cyber Security Regulations

Following Applicable Security Standards

Federal
- FISMA
- DIACAP
- NIST
- <more…>

Critical Infrastructure
- NERC
- FERC
- CFATS
- NIST Cyber-Grid
- ISA-99
- <more…>

International
- ISO
- ITU
- <more…>

Industry
- HIPAA
- PCI
- SOX
- <more…>

Private
- SANS - CAG
- OASIS
- OWASP
- <more…>

And Growing Day by Day……

Cyber Security Standards

Cyber System Security Standards

- FISMA
- DIACAP
- DoD 8500.2
- NIST
- HIPPA
- SOX
- PCI
- OASIS
- OWASP

+

Applicable Industrial Sector Standards

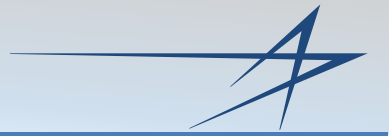
- NERC-CIP
- NIST-Cyber Grid
- Chemical
- Nuclear
- Transportation
- ISA-99

=

Cyber Physical System Security Standards

Cyber security standards can be used to help identify problems and reduce the vulnerabilities in a control system

Cyber Security Controls



- **Management**
  - Risk Assessment
  - Business Continuity Planning
  - Disaster Recovery Planning
  - Incident Management
  - Awareness & Training
  - Security Assessment
  - C&A
- **Technical**
  - Identification
  - Authentication
  - Access Control
  - Accounting
  - Auditing
  - System Protection
  - Communication Protection
  - Encryption and Key Management
- **Operational**
  - Physical Protection
  - Environmental Protection
  - Personnel Security
  - Communication Protection
  - Configuration Management
  - Media Protection
  - Incident Response
- **Monitoring**
  - Risk Assessment
  - Physical Access
  - Media Access
  - Remote Access
  - Environmental Controls
  - Suspicious Activities
- **Maintenance**
  - IDS and IPS
  - Patch Management
  - Change Management
- **Infrastructure Specific**
  - Physical Locations
  - Critical Assets Classification
  - Control Center/Room
  - Control Devices
  - Proprietary Systems
  - Proprietary Protocols
  - Inter - Dependencies

Guide to Industrial Control Systems (ICS) Security at http://csrc.nist.gov/publications/drafts/800-82/draft_sp800-82-fpd.pdf

To build Trust and Confidence in system environment

Cyber Security Controls Example

	ISO 17799	API 1164	IEEE 1402	AGA Report No. 12[f]	NERC Security Guideline	NERC 1200	NERC 1300[g]	ISA TR99-01	ISA TR99-02	PCSRF	IEC 62210	IEC 62351
Availability		✓			✓		✓			✓	✓	✓
ACCESS CONTROL												
Business requirements for access control.	✓	✓			✓			✓		✓		
User access management.	✓	✓		✓	✓	✓	✓	✓	✓	✓		
User responsibilities.	✓	✓	✓	✓	✓		✓		✓	✓		
Network access control.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Operating system access control.	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Application access control.	✓								✓			
Monitoring system access and use.	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Mobile computing and teleworking considerations.	✓	✓			✓			✓	✓			
Field Device Access		✓			✓			✓	✓		✓	

http://www.oe.energy.gov/DocumentsandMedia/Summary_of_CS_Standards_Activities_in_Energy_Sector.pdf

A summary of controls for Energy sector

CYBER SECURITY ASSESSMENT FRAMEWORK

Assessment Objectives

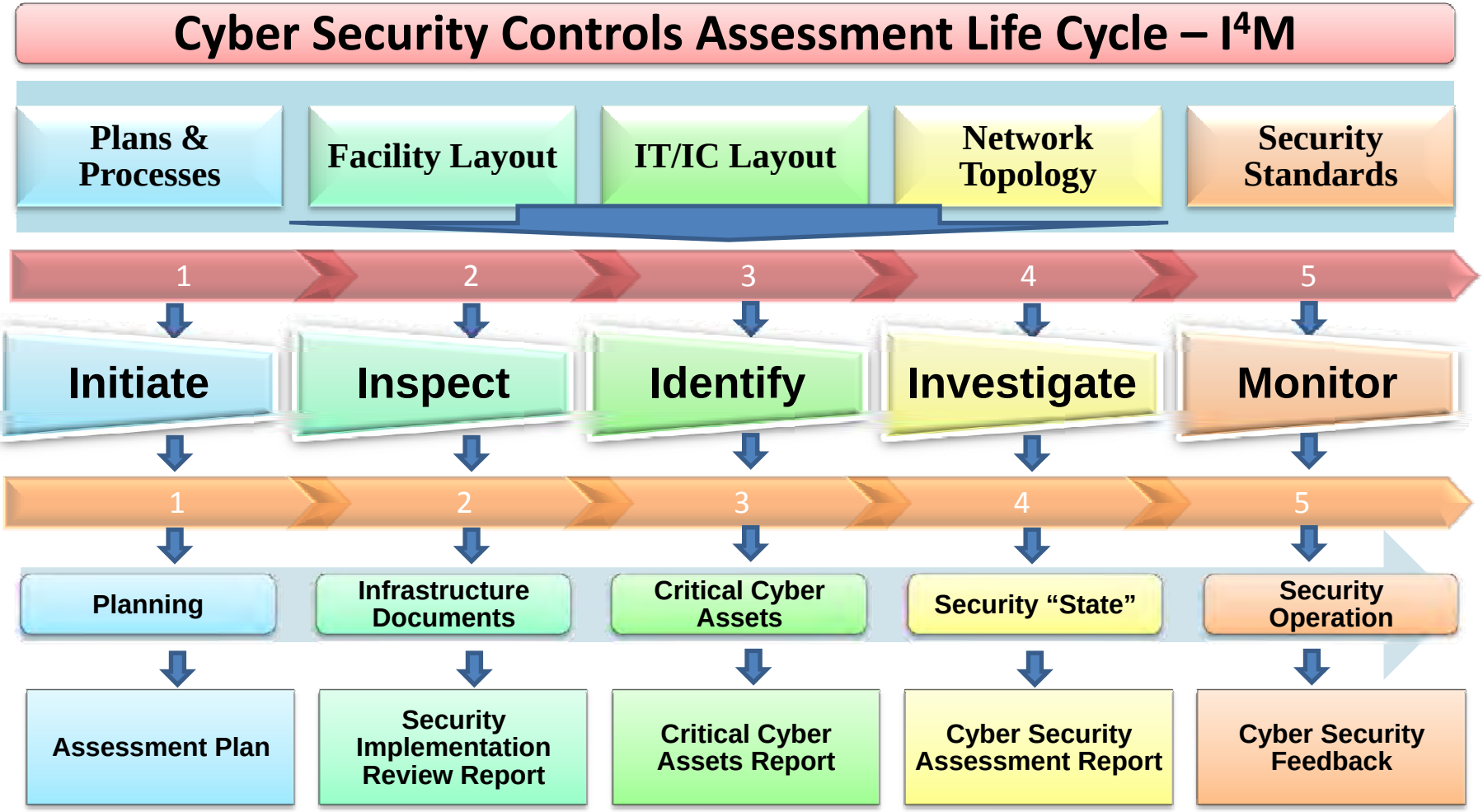
Cyber Security Assessment

The test and evaluation of the cyber system security controls to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting the security requirements for the system

1. **Ensure the confidentiality, integrity and availability of the data**
2. **Ensure safety of people, assets and natural resources**
3. **Ensure compliance to legislative and regulatory Standards**
4. **Ensure protection against security vulnerabilities and threats**
5. **Identify problem areas and provide reasonable options**
5. **Ensure cyber infrastructure is reliable, recoverable and resilient**

Develop the business case for cyber security assessment that will enhance infrastructure security.

Cyber Security Assessment-1



Assess readiness of system and related infrastructure in accordance with security standards/controls

Cyber Security Assessment-2

Initiate

1. Select/Obtain sponsorship
2. Define objectives
3. Select policy and guideline for assessment
4. Identify and gather documentation
5. Develop Assessment Plan

Inspect

1. Domain specific security policies, plans and processes
2. Security requirements and standards
3. Layouts and configuration for facility and environment
4. ITS and ICS security controls documentation
5. Disaster Recovery and Incident Management Procedures
6. Develop Security Implementation Report

Plan and Gain an understanding of security needs

Cyber Security Assessment-3

Identify

1. Criticality Level
2. Critical Functions
3. Critical Assets
4. Critical Asset Location
5. Critical Cyber Assets
6. Infrastructure Interdependencies
7. Develop Critical Cyber Asset Report

Susceptibility to Cyber attacks leading to

- Local Impacts
- Cascading Impacts
- Interdependency Impacts
- Environmental Impacts
- Social Impacts
- Economic Stability Impacts
- National Security Impacts

Identify and rank all critical cyber assets from a security perspective

Cyber Security Assessment-4

Investigate

1. Input, output and expected behavior of critical Cyber assets
2. Security controls (implemented, inherited, legacy, hybrid)
3. Risk management based compensating controls
4. Redundancy and recoverability capability
5. Resources and time to repair
6. Develop Cyber Security Assessment Report

For Threats

- **Natural**
  - Earthquake
  - Storm and Lightning
  - Fire
- **Environmental**
  - Power Outage
  - Chemical Leakage
  - Nuclear Leakage
  - Biological Leakage
- **Human**
  - Computer Abuse
  - Interception & Spoofing, Hacking
  - Sabotage or Vandalism
  - System Tampering
  - Password Guessing
  - Many more……

Understand and capture system security view of critical operation

Cyber Security Assessment-5

Report

1. Assessment of identified critical assets
2. Analysis of the threats to and vulnerabilities
3. Recommendations to reduce vulnerabilities
4. Other information essential for the development of operational security

Monitor

1. Changes in security Requirements and standards
2. Security Controls
3. Patch and configuration management
4. Vulnerability and incident management
5. Risk management
6. Security "state" of Cyber Assets

Continuously monitor and report

VULNERABILITY ASSESSMENT

Vulnerability Assessment-1

Objectives

1. Build awareness - of vulnerabilities for Cyber assets and interdependencies between them
2. Ensure that security vulnerabilities (internal and external) are identified and resolved in a timely manner.
3. Enable management to make informed decisions regarding implementation of security controls and remediation measures

Using

Sources

- Risk assessments
- Vendor advisories
- System test results
- System audit logs

Methods

- Automated vulnerability scan
- Network mapping
- Penetration testing

Vulnerability Assessment-2

Following Applicable Test Techniques

User Interface Test

- Simulate Web Browser
- URL Validation
- Form Validation
- Field Validation
- Workflow Validation
- SQL Injection
- Cross Site Scripting

Static Analysis Test

- Logic Flow Check
- Memory Allocation Check
- Data Type Check
- Data Variables Usage Check
- Buffer Overflow Check
- Error Handling Check

Vulnerability Test

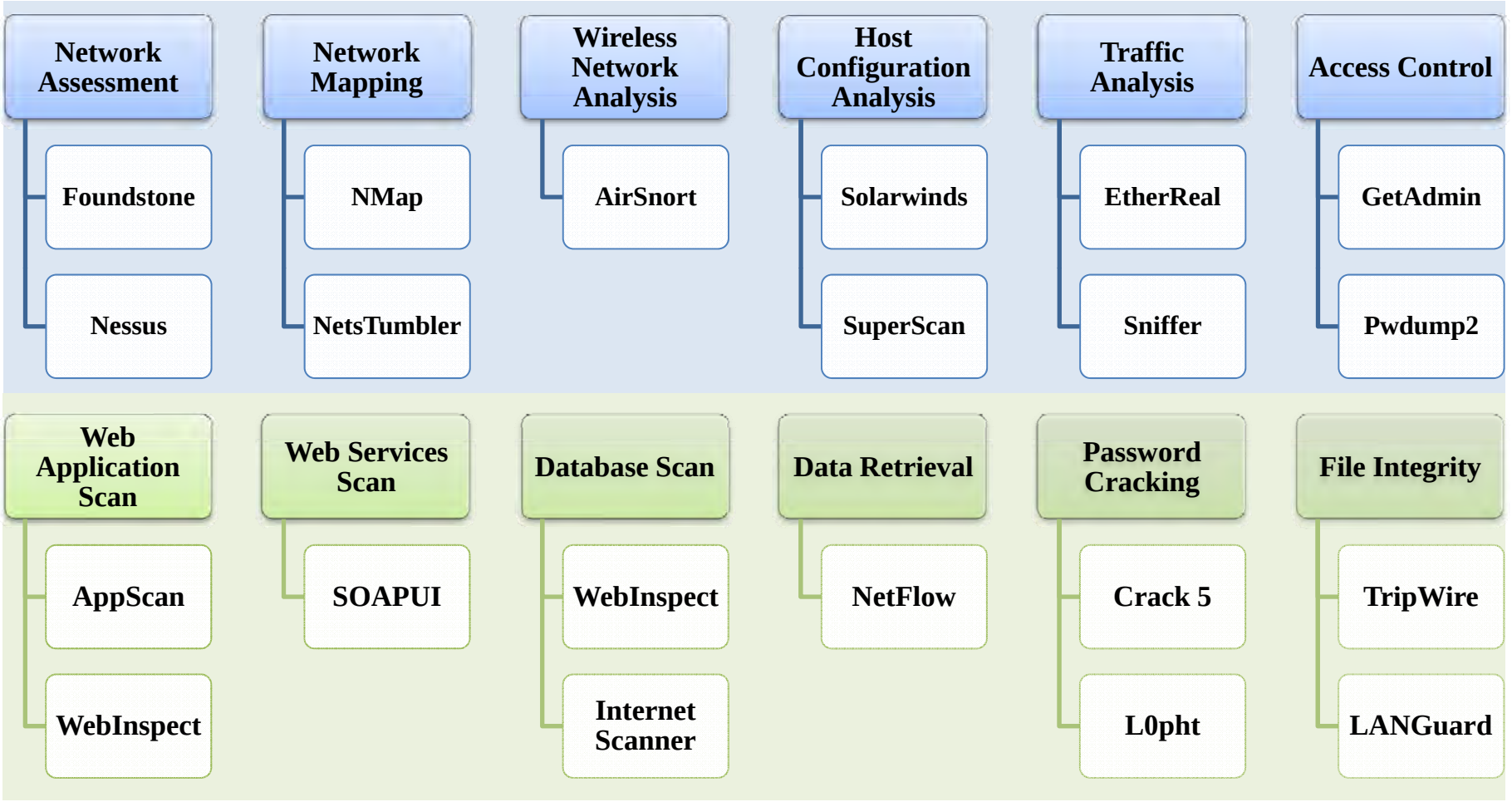
- Operating Systems
- Network Drivers
- Software Libraries
- Software Applications
- Database
- Data Corruption
- Virus Detectors

Penetration Test

- Network Servers
- Network Devices
- Network Protocols
- Denial-of-Services

Vulnerability Assessment-3

And Test Tools



CONCLUSION

Conclusion

Cyber based critical infrastructure assets are vulnerable to cyber attacks because of the increasing interdependence and automation of cyber systems.

A diverse range of measures are required to bridge gap between technology advancement and technology assessment.

This presentation has provided an overview on cyber systems, and assessment framework for the required security controls to protect critical cyber assets.

Lockheed Martin is developing innovative approaches to test, evaluate and assess the security posture of organizations' information system and cyber system environment.

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Acronyms

1. CAG – Consensus Audit Guidelines (SANS 20 security controls)
2. CFATS – Chemical facility Anti-terrorism Standards
3. CIP – Critical Infrastructure Protection
4. COTS – Commercial Off The Shelf
5. DIACAP - DoD Information Assurance Certification and Accreditation Process
6. DCS – Distributed Control System
7. FERC – Federal Energy regulatory Commission
8. FISMA – Federal Information Security Management Act
9. HIPAA - Health Insurance Portability and Accountability Action
10. ICS – Infrastructure Control System
11. IEC – International Electrochemical Commission
12. IED – Intelligent Electronic Devices
13. IEEE – Institute of Electrical and Electronics Engineers
14. ISA – Industrial Society for Automation
15. ISO – International Standards Organization
16. IS&GS – Information Systems and Global Solutions
17. IT – Information Technology
18. ITU – International Telecommunication Union
19. NERC - North American Electric Reliability Corporation
20. NIST – National Institute of Science and Technology
21. OASIS - Organization for the Advancement of Structured Information Standards
22. OWASP - Open Web Application Security Project
23. PCI – Payment Card Industry
24. PCS – Process Control System
25. RTU – Remote Terminal Unit
26. SANS - SysAdmin, Audit, Network, Security
27. SCADA – Supervisory Control and Data Acquisition System
28. SOX - Sarbanes-Oxley Act